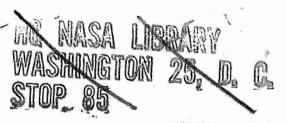


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## ENGINEERING PLANNING DOCUMENT

NO. 45

# SPACE FLIGHT OPERATIONS MEMORANDUM RANGER I

EPD-45

4 October 1961

Compiled by:

M. S. Johnson

G. J. Henninger

JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
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### I. INTRODUCTION

### A. Purpose

The purpose of the Space Flight Operations Memorandum (SFOM) is to summarize, on the basis of the information available at this time, the following:

- 1) Performance of the Space Flight Operations Complex (SFOC).
- Performance of Atlantic Missile Range (AMR), Deep Space Instrumentation Facility (DSIF), Launch Operations Directorate (LOD), North American Air Defense Command (NORAD), and JPL Launch Checkout Telemetry Trailer (LCTT) in tracking and communicating with the spacecraft.
- 3) Analysis of the scientific telemetry data.
- 4) Spacecraft performance.
- 5) Orbital data.

### B. General

Ranger I\* was launched at 10 hours 4 minutes and 10.26 seconds GMT on 23 August 1961, completed 110 orbits, each of approximately 90 minutes' duration, and reentered the Earth's atmosphere during its 111th orbit on 30 August 1961.

### II. SPACE FLIGHT OPERATIONS COMPLEX

The Space Flight Operations Complex (SFOC) responded to the highly nonstandard RANGER I mission in a most satisfactory manner. After initial acquisition by the DSIF and establishment of the fact that the spacecraft was in a nonstandard Earth satellite orbit, the DSIF attempted to track the spacecraft on each visible pass. The Central Computing Facility (CCF) was able to reduce all usable near-real time telemetry data obtained by the DSIF. The magnetic tapes of the telemetry recorded by the DSIF sites were returned to the DRL at JPL for reduction.

### III. AMR PARTICIPATION IN TRACKING RANGER.

The AMR was assigned the responsibility of providing JPL with 1) orbital elements of the parking and transfer orbits, 2) acquisition angles for DSIF #1 and #5, and 3) raw data for the backup role by JPL.

<sup>\*</sup> In its launch configuration, the Atlas/Agena/Ranger is identified as Ranger-1, NASA Mission P32. The Ranger spacecraft, designated as RA-1, when in successful orbit becomes Ranger I.

	TABLE I. ORBITAL ELEMENTS	BITAL ELE	MENTS		
		Parkh	Parking Orbit	Transfer Orbit	rbit
Orbital Element*	Computed By	AMR	JPL	AMR	$_{ m JPL}$
	Data Source	Antigua	Antigua	Ascension	Ascension
		A STATE OF THE STA	Ascension		DSIF
Semi-major Axis of Conic Section (a, km)		6598,03	6580,0	7.6079	6708.9
Eccentricity of Conic Section (e)		0.0071	0,0052	0,0251	0.0249
Inclination (i degrees)		32,72	32,85	32,93	32,93
Right Ascension of Ascending Node ( \Omega degrees)		279.81	279,80	279.81	279,82
Argument of Perigee (ω degrees)		172,41	194.6	198.07	198,36
True Anomaly Plus Argument of Perigee at Epoch ( $V + \omega$ degrees)		141.40	136,5	197.03	197,0133

\* See Table 3. of the Space Flight Operations Plan RANGER 1 (EPD 18) for explanations of the various orbital element definations.

### III. AMR PARTICIPATION IN TRACKING RANGER (CONT'D)

The orbital elements were supplied to JPL, but not at the time required. The elements are shown in Table I. A meeting was planned between JPL and AMR to coordinate and improve the operations in this area for RA-2.

It is believed that the delay in supplying the parking orbit was caused by the necessity of having to first supply look angles to the DAMP ship (Downrange Anti-Ballistic Measurement Program) and to Ascension Island. The loss of the use of the "Twin Falls Victory" (Pershing) tracking ship with its FPS-16 and high data rate (10 points per second) resulted in the attempt to form an orbit with too few Antigua data. The computing facility at AMR lost the use of the majority of the good Antigua data during this computation time. The lost data was subsequently retransmitted and a good orbit resulted.

The transfer orbit using Ascension data was delayed by 1) difficulty in rejecting bad data which was caused by "beacon-stealing" by the DAMP ship, 2) poor radio data transmission conditions, and 3) lack of available telemetry defining the time of second Agena burn. When the data was edited and an assumed nominal time of second Agena burnout chosen, a good orbit resulted.

The raw data from AMR reached JPL with very few transmission errors. Although the Antigua data had no transmission errors, it was not used by JPL because of an input error in the 7090. The Ascension data, however, was used by JPL in real time to compute the initial orbit.

### IV. DSIF PARTICIPATION

The primary tracking load for this nonstandard orbit was borne, as previously planned for such an occurrence, by the Goldstone Az El Station and the Mobile Tracking Station. The Woomera and Johannesburg Stations were secured for the first day as soon as it became apparent that the space-craft was in a near-Earth orbit. The majority of the passes at these stations were either in an area where the antenna could not track or where they crossed at angular rates that exceeded the capabilities of the stations. The Az El mounted antennas at Goldstone and the Mobile Tracking Stations had the rate capabilities necessary to obtain tracking data for orbit determination. After the orbit had been determined, the Johannesburg and Woomera Stations were put back in operation and obtained valuable information on many orbits. Table II presents the possible view periods from the DSIF stations and the periods which were tracked by the DSIF.

Attempts to track were made on 60 orbits, most of which were successful. By successful it is meant that either some position or telemetered information was obtained. The DSIF did better than expected considering the angular rates that were experienced because of the low orbit.

TABLE II. 1
TRACKING CHART

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	1	5	165951	170801	08:10		◆ . Diffe de la Colonia			k		-114	165945
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TABLE II. 5
TRACKING CHART

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TABLE II. 7
TRACKING CHART

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	1	66	123041	123741	07:00		/ / / / / / / / / / / / / / / / / / /		123111	123721	,06:10	-120	
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	. 5	67	140601	140741	01:40		**************************************	+	140631	140741	01:10	-130	Average
Aug. 28	, l <sub>4</sub> _	74	∞1225	001545	03:20							-130	
	4	75	014456	014746	03:20				014426	014716	02:50	- 70	Maximum
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TABLE II. 8
TRACKING CHART

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	<u> </u>	78	062728	062828	01:00				· · · · · · · · · · · · · · · · · · ·			-130	Lock
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			1004519	101139	-V1:00				100)19	101129	100:10		100003
	1	81	104441	105021	05:40				104511	105001	04:50	-113	104442
	-					<del></del>	į. 		**************************************				104845
	, 1	82	121811	122451	06:40				121821	122401	05:40	-119	
	. 5	82	121900	<u> </u>			<u> </u>					- 95	Maximm
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### IV. DSIF PARTICIPATION (CONT'D)

On Orbit 30, 25 August, the Goldstone Az El Station transmitted the Antenna Switch-Over Command, switching the transponder from the high-gain antenna to the omniantenna. On Orbit 31, 25 August, this command was transmitted twice by Goldstone switching the transponder back and forth between the omniantenna and the high-gain antenna.

On Orbits 46 and 47, 26 August, the Hinge Override Command was transmitted by the DSIF 2, Goldstone HA Dec Station. On Orbit 49, 26 August, the Roll Override Command was transmitted by this station. These commands were transmitted primarily to test this station's backup capability.

Except for short intervals, while Ranger I was passing over South Africa on subsequent orbits, Orbit 61, 27 August, was the last orbit during which the transponder signal and the high-rate telemetry were observed. The majority of the time, all stations had been tracking the transponder since only the low-rate telemetry had been available on the beacon.

On Orbit 91, 29 August, Woomera attempted the first track of the day with negative results. A search was made by all stations the rest of the day but neither the transponder nor beacon frequencies were heard. It was concluded that the beacon power supply had failed. The DSIF was secured.

Two temporary modifications were made to the Woomera, Johannesburg, and Goldstone HA Dec Stations to increase their tracking capabilities: 1) the servo hydraulic system was re-plumbed to take out the anti-backlash feature, thereby increasing the tracking rate capability from 1° per second to 1.5° per second with reduced tracking accuracy, and 2) the receiver reference channel was connected to the 6-foot calibration dish that is mounted on the side of the main antenna. Although this modification reduced the system gain by 20 db, it increased the beam width to 10 degrees but left the tracking beam width at approximately 1 degree.

### V. LOD PARTICIPATION

The LOD microlock tracking station at Cape Canaveral supplied, in addition to launch data, one-way doppler data for all passes within their line of sight through 30 August 1961. LOD also recorded certain telemetry data on magnetic tape.

### VI. NORAD PARTICIPATION

Ranger I and the Agena were skin-tracked throughout their lifetimes by the tracking facilities of NORAD. The NORAD Trinidad Station tracked from launch and promptly supplied data indicating that spacecraft-Agena separation had occurred. After loss of communication with Ranger I by the DSIF on 29 August 1961, skin-tracking was continued by NORAD.

### VI. NORAD PARTICIPATION (CONT'D)

NORAD has indicated that Ranger I reentered the Earth's atmosphere on Orbit 111 which would have been completed at approximately 0300 GMT, 30 August 1961. The last contact made with Ranger I was by NORAD's Laredo, Texas site at approximately 0830 GMT, 30 August 1961. At that time, Ranger I's altitude was estimated at approximately 70 statute miles above the Earth's surface.

### VII. LCTT PARTICIPATION

Although it had not been planned to use the LCTT to track beyond the launch phase, a minimum crew maintained a continuing effort from launch through the early hours of 27 August 1931. Additionally, one command was sent to the spacecraft by the LCTT, successfully effecting antenna changeover from omnito high-gain.

### VIII. SCIENTIFIC TELEMETRY

All the Channel B-13 data from AMR, Goldstone, and Woomera has been reduced and distributed to the experimenters. Reduction of data from MTS and Channels B-10, B-11, and B-12 has not yet been completed.

Data Automation System. This system operated correctly with the following minor exceptions:

- 1) There was an occasional complete reset of all data registers between successive passes--perhaps caused by spacecraft power transients.
- 2) There was an occasional program reset within the DAS (i.e., it would start a new frame without finishing the one it was on) of undetermined origin.
- 3) There was an occasional addition of 32 counts to the frame-count register between passes.
- 4) There was an occasional malfunction of the ion chamber time register, probably caused by noise.

Ion Chamber, Triple Coincidence Telescopes, Gold Silicon Detector, and Geiger Tube. All appeared to have operated approximately as expected in the satellite environment.

Cadmium Sulfide Detectors B and C. These detectors are nearly identical in construction, location, and view angle--differing only in that Detector C has a magnetic broom for preventing low energy electrons from

### VIII. SCIENTIFIC TELEMETRY (CONT'D)

being counted. Thus, Detector B should count at a rate equal to or greater than Detector C; however, Detector C consistently had the much higher couning rate. The data are currently being studied in detail to try to find an explanation of this discrepancy. There was a similar, but smaller, discrepancy between Detectors A and D.

Micrometeorite Detectors. Anomalously high counting rates were often recorded by the light flash detector when the spacecraft was in the sunlight. This is presumably due to direct or reflected sunlight and/or Earth light. The instrument operated correctly when in the dark.

Electrostatic Analyzers. These appear to have operated normally. However, the data are very abnormal, probably due to the presence of the ionosphere. Much more study of the data is required.

Lyman Alpha Telescope. Part or all of four pictures and several in-flight calibrations were observed as well as background measurements of Lyman Alpha intensity. There are no indications to date of any malfunction.

Magnetometer. No magnetic field data were obtained, both because the Earth's field at the Ranger I altitude was higher than could be measured with this experiment and because the magnetometer temperature was usually outside the operational range.

Vela Hotel. This experiment apparently operated correctly when the Vela Hotel solar panels received enough sunlight. Most passes were too short to obtain any useful data.

### IX. SPACECRAFT PERFORMANCE

Present knowledge of the spacecraft performance indicates that separation from the Agena appears to have been normal.

The spacecraft controller commands were all executed. The exact times are not known but there is no reason to believe the times were not nominal.

The following indications of a malfunction were noted:

- 1) The attitude control converter voltage measurement was at zero (0) volts.
- 2) The sun sensor and light detector outputs were at zero, substantiating the above.

### IX. SPACECRAFT PERFORMANCE (CONT'D)

3) The rate gyro measurements had slightly more than two spikes per second. The attitude control converter appeared to have returned to normal by the first pass on 25 August 1961.

The attitude control system was inoperative on 24 August. While it was apparent that the attitude control gas was exhausted by 25 August, it was suspected that it had been exhausted by 24 August. Because of the above conditions, there were no apportunities to observe the attitude control system in action after the first day of the mission. An attempt is being made to determine if the attitude control performance was normal for a Ranger spacecraft in a near-Earth satellite orbit.

The communication system functions appear to have been qualitatively normal. The radio command to transfer from the omniantenna operation to high-gain antenna operation was sent four times and was successful each time. All commands were sent by Goldstone except the one sent by the JPL LCTT.

Spacecraft temperatures appear to have been normal for a spacecraft on this orbit.

The solar panels and the Solar Corpuscular Radiation boom were extended successfully. This is deduced from the temperature and solar panel currents data since the blip channel was inconclusive.

The friction experiment was turned on and operated for 17 hours. Data was received and is being analyzed.

### X. ESTIMATION OF THE ORBIT OF RANGER I

Table III presents the orbital parameters for Ranger I. These, not the best possible, are the best obtainable using the Orbit Determination Program (ODP) for RA-1 and 2 with angle data only. The ODP, designed for use with deep space probes similar to the RA-1 standard trajectory, lacks certain features which are mandatory for the determination of orbits of low-altitude satellites. Consequently, Dr. J. W. Siry of Goddard Space Flight Center has been requested to determine the final orbit of Ranger I, using the techniques he has developed for this purpose. Further effort will not be expended at JPL in this area.

The largest source of error in the orbital parameters found in Table III is due to the exclusion of any type of drag effect which would compensate for that experienced by the spacecraft during the decay of its orbit. This fact makes it desirable to redetermine the orbit for each excursion about the earth, and necessary to minimize the number

### X. ESTIMATION OF THE ORBIT OF RANGER I (CONT'D)

of excursions based upon a single set of orbital parameters. The next largest, known source of error in these parameters is the exclusion of frequency data. Some of the good frequency data of each type was obtained during some view period by one of the DSIF stations. Difficulties, gradually being resolved, have been experienced in attempts to include this type of data. However, the nature of the orbit should minimize the contribution of error from this source. The last known source of error is due to the inherent difficulties experienced by the DSIF when attempting to track Ranger I. The overwhelmingly powerful signal coupled with the high frequency and angular rates (conditions for which the DSIF antennas were not designed) made it extremely difficult to obtain good tracking data during every view period and not to track side lobes.

Compromising these factors, a new set of orbital parameters is given for each day Ranger I was tracked. The epoch on each day was chosen to be just prior to the start of the set of new periods at Woomera. The orbit defined by these parameters should not be used beyond the last new period at South Africa. Thus, each orbit is designed to be applicable for approximately 14 hours. Clearly, as time moves away from the epoch of injection on each day, the spacecraft orbit decays further, and the orbit determined by the orbital parameters in Table III degenerates.

# TABLE III. ORBITAL PARAMETERS OF RANGER I

		Time of injecti	nci				Ic hoods	Epoch of Pericenter Passage	Passage	Feriod
פ		ЯФ	13 00	·× >	** *	·Z o	aj Qi	ָּד י	3 <b>%</b>	Apogee Perigee
8-23-61, 10b 26m 36 sec 2437043054 .6542164854 7837125	(1 + +	26m 36 sec .60054081E4 7837125431	89207321E3 .34396299E3	59845351E1 -75056397E1	3057930751 83381240E-1	4156675921 12400113E3	8-23-61, .6709.03 .024911	10h 27m 23.106 sec 32.9283   197.788 279.8169   -3.2601	.106 sec 197.788 -3.2501	91.1483 313.337 105.597
8-24-61, 5h 20m 0 sec .159376755466602 .6427753854	12 44	Om O sec 6660218994 -6634657421	.7176016753	.6115925251 .7150733541	.13709913E1. .34633794E0	.3544.85052	8-24-61, 6693.63 .030846	4h 38m 42.202 sec 32.9237 206.83 274.1791 164.32	202 sec 206.828 164.324	90.8346 236.614 113.172
8-25-61, 1h 50m 0 sec 36637562E4 .43113 .65356489E422215	v + +	Om O sec .4311305554 2221555752	2471038334 .1267340653	494.3639951 7493572851	53200141£1 02£80£0441.	30574.595±1 -11:633590±3	8-25-51, 5575-37 5321334	15 48.742 32.9008 215 254.1813	742 sec 215.329 9.034	90.4336 277.692 100.645
8-26-61, Oh 20m O sec 2003184654 .59413 .653939332416505	e 33	Om O sec .594130223- -1650572023	1857914224 .1296155623	617 <i>9</i> 700021 -7+50268331	3250513321 2750124450	35375549m	8-26-51, 6559.47 .018598	32.9074   225.976 25.3795   225.976 251.3795	176 sec 225. <i>9</i> 78 -14.443	90.1401 255.625 101.686
8-27-61, Oh 15m O sec -,32633687E3 .64037 .65485475E411718	р 1 E4 E4	5m O sec .6403742134 1171877752	13300636±4	1.8684593331 1.856716647.		3945295811 123523233	8-27-51, 6639-59 Olóli?	On 22m 46.763 sec 32.9141 234.133 254.2250 -32.18	763 sec 234.132 -32.182	39.7370 232.818 99.306
8-28-61, Oh 15m O sec 1359560824 .59559 .6534-66692420790	5. 5. 1 5. 5. 1	Jm O sec .5955955+54 .20790533E2	2319+96354		25¢-81¢5±. 32¢53381£3	1.321605121 1.17506-213	3-23-61, %12.56 %1273	0h 16m 1.986 sec 32.9076 245.71 225.9342 -24.3	36 sec 245.768 -24.974	89.1915 202.914 96.231

S , squatorial, space fixed rectangular Cartesten condinate system. Z is assumed justitive north, K is normal to 2 and sositive in the direction of the vernal X/Y,Z,X,Y,Z - a right handed, earth centered, squetorial, space fixed rectargular Carteelen coordinate system. lie along the earth spin axis equinox, km, km/sec.

a right handed, earth cellerel, equatorial, earth fixed rectangular Cerrectan coordinate system. R is from earth center in km, \$\docume{\documents}\$ is latitude measured from equatorial plane positive nurth in degrees, \$\theta\$ is longitude measured eastward from the Greenwickemeridian positive eastward in its parth fixed velocity in \text{im}/sec, \$\gamma\$ is pitch angle of spacecraft with respect to local horizonral in degrees, \$\gamma\$\$ is azimin angle of \$\gamma\$\$ measured east of true north in degrees. F, D, 8, V, Y, G -

semi-major axis, km
 eccentricity
 inclination of orbit plane to equatorial plane, deg.

A. longivude of assending node, degrees w - organism of garieso, degrees
y - true anomaly, degrees

period - minutes apogee - statute miles perigee - statute miles

All times are in Giff